



Effects of Agitation on Fruit Fly Populations

Target Audience

5th-8th grades

(could be adapted for 9th-12th grades)

Goals

- Replicate a space biology experiment with students.
- Relate NASA research to students' lives.
- Provide a meaningful way to practice the scientific method.
- Conduct a scientific experiment.

Learning Objectives

- Discover and list three effects of agitation on fruit fly populations.
- Conduct an experiment to answer a question.
- Analyze experiment results and draw conclusions.

Standards and Skills

Science (National Science Education Standards)

- Science as Inquiry
 - Abilities necessary to do scientific inquiry
 - Understandings about scientific inquiry
- Life Science
 - Reproduction and Heredity
 - Regulation and Behavior

Mathematics (National Council of Teachers of Mathematics)

- Number and Operations
 - Compute fluently and make reasonable estimates
- Communication
 - Organize and consolidate their mathematical thinking through communication
- Connections
 - Recognize and apply mathematics in contexts outside of mathematics

Technology (International Society for Technology in Education)

- Technology productivity tools (microscopes)
 - Students use technology tools to enhance learning.
- Technology research tools
 - Students use technology tools to process data and report results.

Science Process Skills (the American Association for the Advancement of Science)

- Observing
- Predicting
- Communicating
- Collecting Data
- Identifying and Controlling Variables
- Experimenting

Background Information

Scientists worldwide study *Drosophila melanogaster* (the common fruit fly). The species' short life cycle, ability to reproduce quickly, complete genomic map, and small size make it an ideal candidate for analyzing biological processes and genetics. Fruit flies enable researchers to model systems like humans' innate immune system. Studying the effects of weightlessness and radiation exposure on fruit flies can provide critical preliminary information about the potential effects of space travel on humans.

Researchers conduct experiments with fruit flies on the Space Shuttle and International Space Station (ISS) in preparation for sending humans on future missions.

Activities and movement on the Space Shuttle or ISS can agitate fruit flies. Understanding the effects of these disturbances on fruit flies' ability to lay eggs can provide information about how to maintain a stable population of fruit flies. Since *Drosophila* researchers benefit from studying several generations of flies in space (and upon their return to Earth), it is essential to comprehend factors which affect population growth.

This experiment was originally conducted by four astronauts as part of a class about *Drosophila* and conducting biological research in space. You will now have a chance to replicate this experiment! This activity is a structured-inquiry activity although could be adapted as a guided inquiry activity if the students design the procedures.

Teacher Materials

For a class of 30 students

- Fruit flies (order a kit from a science supplier or attract them with a mixture of the following [see recipe below])
 - Fresh bananas and/or peaches
 - Water
 - Packaged bakers' yeast

- 30 plastic jars, flasks, or test tubes to collect fruit flies
- Cotton plug or foam lids for the jars/flasks/test tubes
- 30 plastic containers (250 mL polypropylene Erlenmeyer flasks, for example) for egg-laying
- 120 small Petri dishes (60mm x 15mm) that just fit over the mouths of the Erlenmeyer flasks (4 per flask)
 - 1 dish while the flies get settled
 - 1 dish for the first agitation
 - 1 dish for the second agitation
 - 1 dish to use after the second agitation
- Fruit fly egg-collecting medium (see recipe below or order instant medium from a science supplier)
 - 4.5 liters of water
 - 176 grams agar
 - 750 mL light corn syrup
 - 76 mL 10% p-Hydroxy-benzoic acid methyl ester in 95% ethanol (or other mold inhibitor)
 - blue food coloring
- Microscopes for each pair of students
- Shaker plates (optional)

Safety

Understand the Materials Safety Data Sheets (MSDS) for materials required for this experiment. MSDS can be found at <http://www.msdssearch.com/msdssearch.htm>.

Teacher Preparation

1. Place fruit fly medium in plastic flasks. Gather fruit flies* in flasks. Place cotton plugs on top of the flasks to enable the fruit flies to breathe and to prevent escape.

*Harvest fruit flies. One to two weeks prior to the study, mash ripe bananas, add water and a bit of packaged yeast and place in the bottom of a jar/flask. This will attract fruit flies. After about one hundred flies are collected in the jar, cover the jar with a piece of foam or cotton. The larval stage can only be seen with

a microscope inside the mashed fruit mixture in the jar.

Note: these flies may be subject to bacterial growth if harvested in this medium. To reduce the bacteria's affect on the flies, use flies as soon as possible after harvesting them.

If this method fails, order flies from a vendor. Depending on the season, climate, and geography, it may be difficult to attract the right kind of insect. That is an experiment in itself!

Ideally each flask will have ≥ 100 flies for the test population and ≥ 100 flies for the control.

2. Prepare Petri dishes with fruit fly medium for collecting eggs.

This is a firm medium that keeps well and makes a good base for egg collecting. Wrap filled Petri dishes and store at 4-- 14°C (they should keep for at least 6 weeks). Add blue food coloring to enhance the egg-viewing. This recipe makes about 60 6 x 2 cm plates.

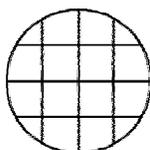
Ingredients

- 2.25 liters of water
- 88 grams agar
- 350 mL light corn syrup
- 38 mL 10% p-Hydroxy-benzoic acid methyl ester in 95% ethanol

Cooking instructions

- Mix water, agar and syrup.
- Boil until agar is dissolved.
- Cool for 5 minutes or more.
- Stir in p-Hydroxy-benzoic acid methyl ester.
- Dispense into Petri dishes.

To facilitate the egg counting, it is helpful to mark the Petri dishes with a grid. Using a permanent marker, draw a grid (with squares approximately 1cm



in length/height) on the bottom of the dish. (See diagram to the right.) When the students count the eggs, they can count the number per square so they do not lose count.

3. Prepare experiment flasks: Cut a square hole in one side of the flask. Plug it with foam or cotton to allow flies to breathe but not to escape.

4. Transfer flies from the original jars to the experiment flasks.

5. Place Petri dishes on top of the flasks. Tape the flask/Petri dish combinations shut so the flies do not escape. Invert the flask/Petri dish combinations. The flies will lay their eggs on the medium in the Petri dishes.

Student Materials

(for each student)

- Fruit flies in a plastic container
- 4 small Petri dishes filled with food
- Microscopes for each pair of students
- Shaker plates (optional)
- Student handout (attached)
- Permanent markers or masking tape & pen to label Petri dishes after agitation and whether they are test/control

Introduction

Discuss with students the concepts of exploration, studying fruit flies, and space biology.

- Have you ever explored somewhere new? Was there anything dangerous about it? What dangers did you encounter?
 - NASA astronauts will be traveling to the Moon and Mars. We want to keep them safe on their journey, but all the dangers are not yet known. NASA's life scientists are trying to characterize the risks of space travel to minimize the dangers.
- Why do scientists study fruit flies?

- Studying them can lead to insights about humans. Specifically, their innate immune system is similar to humans.
- Why do NASA scientists study fruit flies?
 - To gain insights about the effects of space travel on living organisms such as humans.

Research Question

What effect does agitation or disturbance have on *Drosophila* egg-laying?

Hypothesis

Agitation or disturbance of the fly's environment reduces the rate of egg-laying and therefore reduces population size.



Exploration (Experiment Procedure)

1. Observe fruit flies in their experiment flasks. Note behaviors, locations, and other interesting facts.
2. Flies should remain in the experiment flasks for at least 45 minutes (overnight is ok) in order to get settled in their new environment. They will begin laying eggs (visible with the naked eye) on the Petri dish.
3. After the flies are settled in the new environment, change all the Petri dishes to fresh supplies of food.
4. Predict the number of eggs that will result on test and control Petri dishes. (Note: female fruit flies normally lay up to 100 eggs each day).
5. Place control Petri dishes nearby in an undisturbed location.
6. Agitate the flies:
 - Gently tap the experiment flask against the tabletop 5 times. Repeat this process every 15 minutes. Exchange the Petri dish in the experiment flask before each round of tapping. At the same time, exchange the Petri dish in the control flask. Label the Petri dishes in the order that they come out of the flasks to facilitate data analysis.
 - Another option is to place the experiment flask on a shaker/vibration plate. Agitate the flies at 50 rpm for 5 minutes, then let them rest for 10 minutes. After this period, exchange the Petri dishes in the experiment and control flasks. Repeat agitation.
7. Examine Petri dishes under a microscope. Note any observations.
8. Count the number of eggs laid on the control and test fly Petri dishes. Compare. Create a whole-class comparison chart to show results from all of the Petri dishes. Students might post their results on the board or on an overhead for everyone else to see.

	Number of eggs on control Petri dish	Number of eggs on test Petri dish
Agitation 1		
Agitation 2		

9. Express results and observations of the fruit fly populations using graphs, demonstrations, drawings, diagrams, or tables. (A bar graph showing the number of eggs over each time period would be appropriate.)

10. Review the hypothesis. Do your results support your hypothesis?

Discussion

Have students share their observations and findings.

Extensions

Design experiments to test the following questions:

1. What is the effect of different frequencies or types of disturbances on *Drosophila*?
2. What behaviors do you observe from vibrated/vibrating flies?
3. How do different strains of fruit flies respond to agitation?

Student Worksheet

Research Question

What effect does agitation or disturbance have on *Drosophila* egg-laying?

Hypothesis

Agitation or disturbance of the fly's environment reduces the rate of egg-laying and therefore reduces population size.

Experiment Procedure

1. Observe fruit flies in the experiment flasks. What do you notice? What are they doing? Where are they located in the containers? Describe and sketch what you see.



2. Change the Petri dishes in the experiment and control flasks so all the flies have a fresh supply of food.

3. Make a prediction. How many eggs do you think will be on the test Petri dish after 1 hour? _____
How many eggs do you think will be on the control Petri dish after 1 hour? _____
(Note: female fruit flies normally lay up to 100 eggs each day.)

4. Prepare to agitate test flies. Place the control flies near the test flies in an undisturbed location. What variable are you testing?

5. Agitate test flies by gently tapping the test flask against the tabletop 5 times or by placing the test flask on a shaker/vibration plate for 5 minutes at 50 rpm.

- Allow the flies to rest (and lay eggs) for 15 minutes.
- Replace the Petri dishes in the test and control flasks with fresh dishes. Label the dishes **Test** or **Control** and the number of the agitation they correspond to (example: Test 1 for the first dish, Control 1 for the dish that comes out at the same time).
- Agitate the flies again, allow them to rest for 15 minutes, and replace the Petri dishes.
- Repeat this process.

	Time started	Time stopped	Observations of fruit flies during agitation
1 st Agitation			
2 nd Agitation			

Observations

6. Examine Petri dishes under a microscope. What do you observe? Describe and draw it.



Collect Data

7. Count the number of eggs laid on your control and test fly Petri dishes.

	Number of eggs on control Petri dish	Number of eggs on test Petri dish
1 st Agitation		
2 nd Agitation		

Draw Conclusions

8. Express your results and observations of the fruit fly populations using graphs, demonstrations, drawings, diagrams, or tables.

9. Review the hypothesis. Do your results support your hypothesis? Explain why or why not.

Extensions

Design experiments to test the following questions:

1. What is the effect of different frequencies or types of disturbances on *Drosophila*?
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